Five Ways Software

Approximation, estimation, and standard form

Designer
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Five Ways

Heinemann Computers in Education

H·C·E
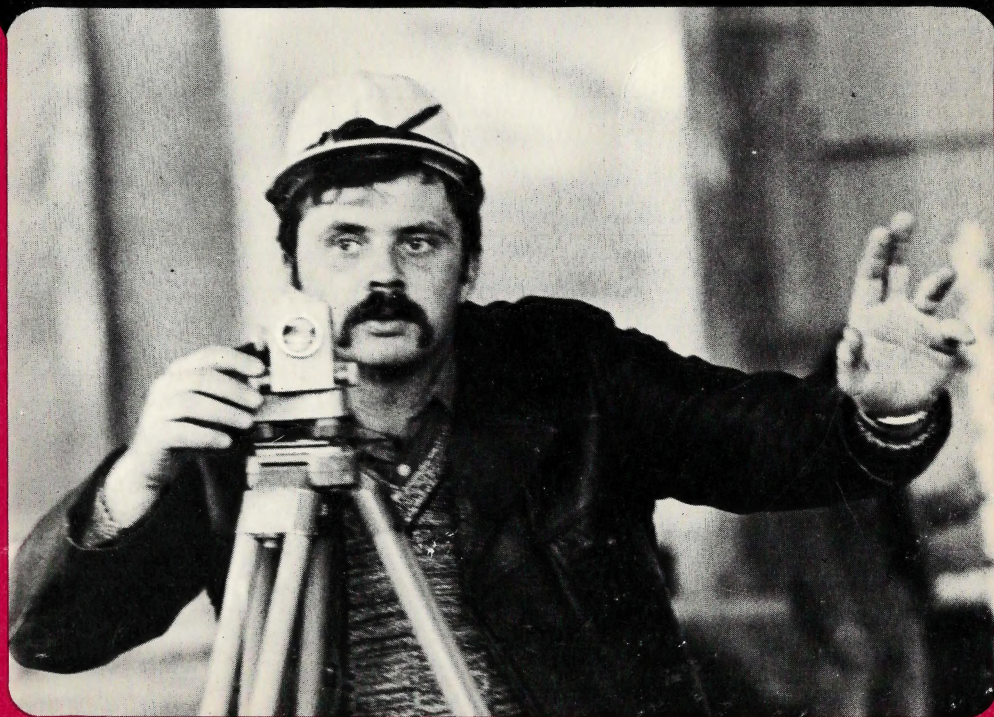
Starting up

All machines
1 Switch on TV monitor(s).
2 Switch on Apple (rear left corner).
3 The disk light should now come on.

DOS 3.2 machines
1 Insert program disk in the disk drive with light on (see diagram below).
2 Close disk drive door.
3 Wait for a few seconds . . . the program will be entered automatically.

DOS 3.3 machines
1 Insert DOS 3.3 BASICS disk in the disk drive with light on (see diagram below).
2 Close the disk drive door.
3 Wait for message to appear on screen.
4 Replace DOS 3.3 BASICS disk by program disk.
5 Close the disk drive door and press **RETURN**.
6 Wait for a few seconds . . . the program will be entered automatically.

Note If your machine has a **language card**, follow the steps for DOS 3.3 machines.

Technical details

Minimum configuration
48K RAM
Single disk drive
Applesoft must be in ROM or machine must possess a language card.
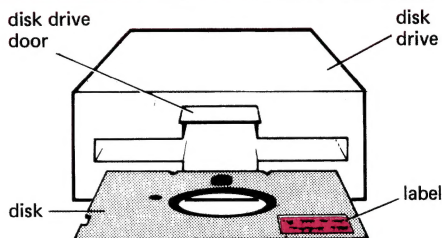
About the program disk
Disk contains DOS 3.2.1.
Disk is single-sided and copy-protected.
Do not save other programs on this disk, or write-protect it.

How to insert a disk
1 Open the disk drive door.
2 Remove any disk already in the drive.
3 Insert new disk (see diagram).
4 Close disk drive door.

disk drive door · disk drive · disk · label

In case you need help

Telephone   021 - 475 1874

Or write to   HCE Query Service,
Ilmington School,
Ilmington Road,
Birmingham   B29 5LL.

For the Apple II

Approximation, Estimation, and Standard form

Five Ways

Teaching notes

Contents

Acknowledgements

1 Introduction

Five Ways Software is a series of resource materials for teaching and learning with the aid of microcomputers. The programs, designed by teachers, and the accompanying teaching notes have been written so that those with little or no knowledge of computers can use the disks with confidence and ease.

There are various ways in which a computer can be used to aid the teaching and learning process. The uses prevalent in schools can conveniently be divided into two main types:

    (a) the teacher demonstrates an idea or topic using the computer;
    (b) the pupils themselves use the computer.

The equipment requirements for each of these two approaches are rather different, as are the organizational problems involved. A discussion of ways in which the problems may be overcome, even when equipment is limited, may be found in *Computer Software for Schools* (London: Pitman, 1980).

Some teachers will be using computer-aided learning materials for the first time. Section 2.3 (page 7), 'Some suggestions for possible uses', has been included especially for their benefit. The suggestions given are intended to help first-time or inexperienced users increase their appreciation of the versatility of computer-aided learning materials. Once familiarity has been gained, the teacher will doubtless develop his or her own ways of using the materials.

The provision of equipment and the degree of experience in using computer-aided learning materials are only two of the factors that differ from school to school. Class size, range of ability, and teaching methods also vary considerably. As far as possible, these software packs have been designed to take account of these variations and to lend themselves to flexible use. In particular, they can be used to support a variety of teaching styles and may therefore be incorporated into lessons and courses as and when each teacher desires.

Throughout the development of the *Five Ways Software* materials the Project Team has been grateful for the many comments, suggestions, and criticisms that individual teachers have made when viewing early drafts. We hope that this process will continue. To this end we would value any suggestions for improvements or for other topic areas we might investigate. We can be reached through the Heinemann Computers in Education Query Service at the address given on the inside front cover of this booklet.

We have enjoyed developing these materials. We hope that you and your pupils will gain enjoyment and benefit from using them.

PROJECT TEAM

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2 Notes for teachers

2.1 Program description

For the majority of school children the most important aspects of mathematics involve numbers and the ability to relate numbers to measurements in the real world. This program is designed to stimulate children to think more about numbers and how to manipulate them. It should develop skills such as quick and accurate estimation which can be particularly useful in scientific applications. It does not aim *either* to teach the topic *or* to decide which method is appropriate in a given situation.

Each of the options provides practice in one of two separate topics or a random mixture of both. The options are:

- **Approximation**
    (a) rounding to a given number of decimal places only;
    (b) rounding to a given number of significant figures only;
    (c) a random mixture of (a) and (b).

- **Estimation**
    (a) multiplication questions only;
    (b) division questions only;
    (c) a random mixture of (a) and (b).

- **Standard form**
    (a) standard form to floating point only;
    (b) floating point to standard form only;
    (c) a random mixture of (a) and (b).

In addition, pupils (or the teacher) can select the level of difficulty of the questions within each option. The number of levels of difficulty varies and is summarized in Section 2.4.

Once the type of question and level of difficulty have been set, the computer will generate appropriate exercises.

ESTIMATION OPTION
An extra feature of this option is that the pupil (or teacher) can choose the accuracy range within which the computer will accept the answer. A **bonus** is also available, as described in Section 3.6. This bonus is determined by the accuracy range which has been set (see Section 3.4).

2.2 Prerequisites

Since none of the three options attempts to teach the respective topic, the pupils will need to have been introduced to the topic the teacher wishes them to practise and, in most cases, to the method he or she wishes them to use. It is not necessary to introduce the entire topic before the pupils can use the relevant program to good effect; indeed, many teachers may wish to introduce part of a topic and then allow the pupils to practise this aspect before taking the topic further.

2.3 Some suggestions for possible uses

The main use of this program is to provide pupils, either as individuals or in small groups, with graded practice in a particular topic. However, experience has shown that it can also be used successfully by the teacher as a demonstration when introducing a topic. If the computer is to be used for classroom demonstration it is important to ensure that the pupils can read the screen. Teachers who are inexperienced in using computers in classroom demonstrations may be surprised how close many pupils need to be to a large television screen before they can read it clearly. This is particularly important when numbers are involved since the pupil has to be able to read each character. The use of two screens may help to solve the problem.

One example of how the program may be used is described below:

(a) the teacher introduces the part of the topic he or she wishes the pupils to practise;

(b) the teacher (or pupil) selects the option, topic, and level of difficulty (see Section 3);

(c) pupils then practise the exercises at the computer, either individually or in small groups.

As the number of computers owned by most schools at present is very small, it is likely that there will be too few keyboards available at any one time to allow more than one or two pupils to work at the computer during the lesson. Thus practising the topic on a computer may be one of several activities.

If pupils can gain access to a computer outside class lessons the program will allow them to practise the various topics in their own time. Experience shows that most pupils enjoy working at a computer in this way although, inevitably, they will experiment with other options and topics (whether they have been taught them or not), and also vary the level of difficulty they tackle.

2.4 The data

In all the options questions are generated at various levels of difficulty. This section describes the type of question the user will meet in each of the three options.

APPROXIMATION OPTION

The computer generates numbers of the form $A \cdot X$ where the range of possible values for A and for X are controlled separately for all six levels of difficulty. Furthermore, the range of possible values is controlled at each level of difficulty so that the questions become progressively harder. Holding down CTRL and pressing P at any stage causes the program to jump to the hardest question within that level.

ESTIMATION OPTION

In this option the computer generates two numbers of the form $A \cdot X$ and $B \cdot Y$ where the range of possible values for A or B and for X or Y is controlled separately for all ten levels of difficulty. Division problems are further controlled since, in simpler levels, $A \cdot X$ is always greater than $B \cdot Y$.

STANDARD FORM OPTION

The computer generates numbers of the form $A \times 10^p$ where the program controls

    (a) the number of digits in A;
    (b) the range and frequency of the values of p.

There are six levels of difficulty. Negative powers are excluded from simpler levels.

Running the program   3

3.1 Choosing an option

Once the title screen has appeared for a short time you will be presented with a menu of **options,** as shown in Fig. 3.1.

Enter your choice by typing in the appropriate number (from 1 to 4) and confirm it by pressing RETURN . Press ← before you have pressed RETURN to cancel any character you have typed in error.
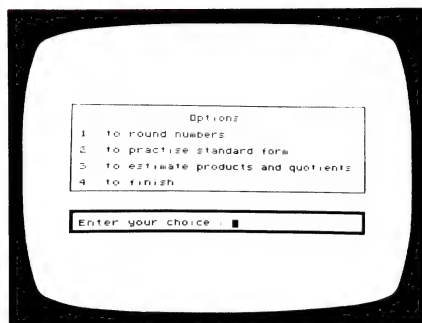

Fig. 3.1

3.2 Choosing a topic

Once you have selected and confirmed your option, the topics will be displayed. Initially the arrow points to the middle topic, as shown for
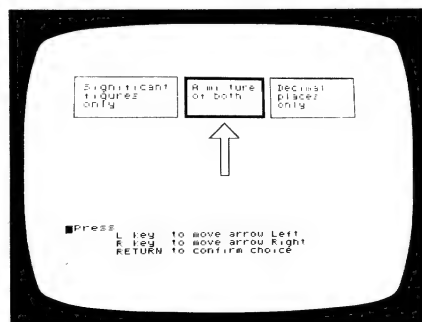

Fig. 3.2

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the Approximation Option in Fig. 3.2. You can change its position by pressing

L to move the arrow **left**;
R to move the arrow **right**.

When the arrow points to the desired topic, confirm your choice by pressing RETURN.

3.3 Setting the level of difficulty

Once the topic has been selected you will be presented with a screen displaying the level or levels of difficulty appropriate to your option (see Section 2.4). The level of difficulty is indicated by a solid (white) bar (see Fig. 3.3). The higher the bar, the more difficult the questions will be. The height of the bar can be altered by pressing

U to move the bar **up**;
D to move the bar **down**.

Once the bar has been set to the required level, confirm its position by pressing RETURN.
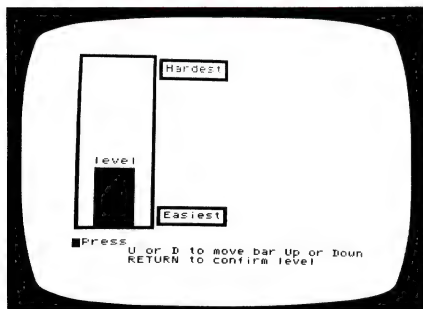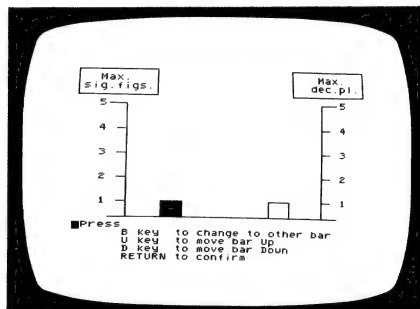

Fig. 3.3

Fig. 3.4

APPROXIMATION OPTION

The procedure for setting the levels of difficulty for this option needs further explanation if the topic selected is A mixture of both. Figure 3.4 shows the display in this case.

Here you may set *both* the maximum number of significant figures *and* the maximum number of decimal places. The height of the solid (white) bar is changed by pressing U or D as before. Initially, the solid bar is on the left (to set the maximum number of significant figures). Highlight the bar on the right (to set the maximum number of decimal places) by pressing B.

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3.4 Setting the accuracy level

This section applies only to the Estimation Option. Once the level of difficulty has been set (as described in Section 3.3) you will be presented with the screen shown in Fig. 3.5.
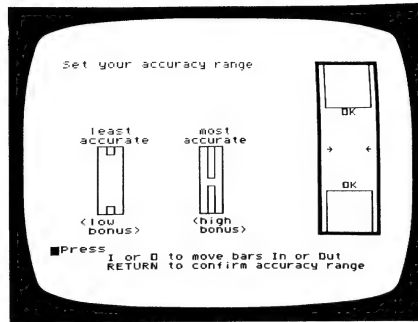

Fig. 3.5

The bars on the right of the screen define the range within which the answers will be accepted as sufficiently accurate. There are eight settings for this range. A more challenging accuracy range is set by moving the bars closer together; the range is less challenging when the bars are further apart. Press

I to move the bar **in**;

O (the letter, not the number) to move the bars **out**.

Once the desired accuracy range has been set, press RETURN to confirm it. This range remains on the screen throughout the exercise and is used to show whether your answer is sufficiently accurate (see Section 3.5).

The setting of the accuracy range also determines the bonus which can be scored—the closer the bars, the more accurate the answers must be, and so the higher the bonus given.
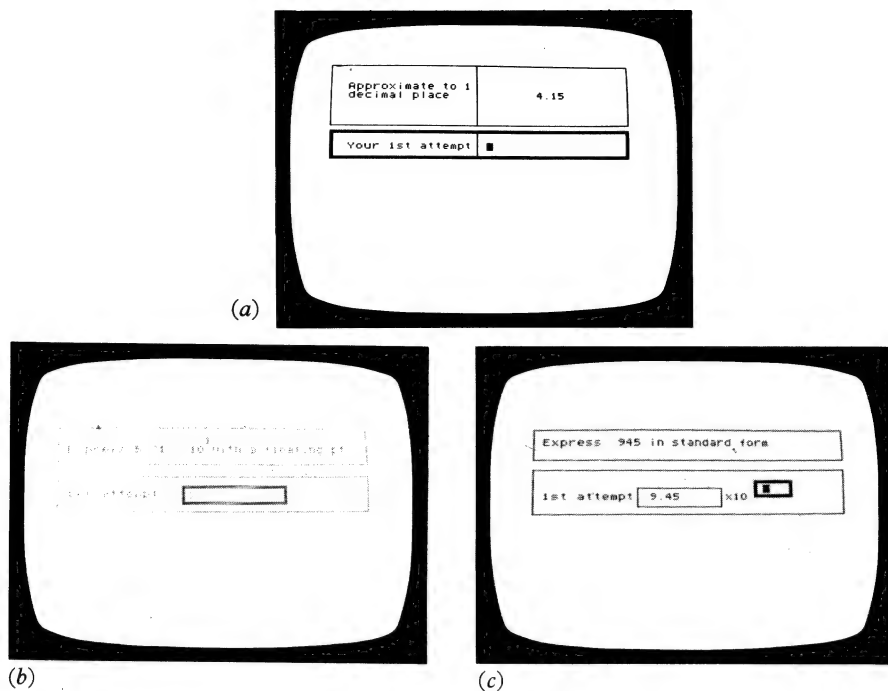
(a)

Approximate to 1
decimal place   4.15

Your 1st attempt ■

(b)

(c)

Express   945 in standard form

1st attempt 9.45   x10

Fig. 3.6

3.5 User responses

Once the various options and levels have been set, a question will appear, as shown in Fig. 3.6. If you make a mistake while answering it, press **←** to cancel the last character which you typed. When you are satisfied with your response, press **RETURN** to confirm it.

If your answer is correct you can press either

space bar to generate the next question, or
ESC to see the score display (see Section 3.6).

If your answer is incorrect you are allowed a second attempt. If your second answer is also incorrect, the correct one will be given.

At the end of each completed question you can either view the score display (see Section 3.6) and then, if desired, return to the menu (by pressing **ESC**), or you can simply generate another question by pressing the **space bar** .

If **RETURN** is pressed before any digits have been entered, the computer will automatically record the response as incorrect and give you the correct answer.

APPROXIMATION OPTION

In this program, after an incorrect attempt, your attention will be drawn to the digit that you should concentrate upon in order to answer the question correctly. This is illustrated in Fig. 3.7.
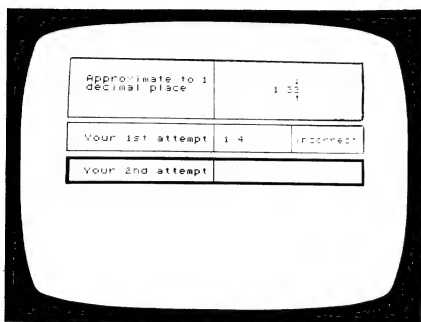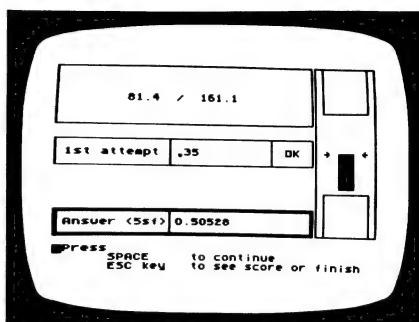

Fig. 3.7

Fig. 3.8

ESTIMATION OPTION

In this option an answer will be accepted if it is inside the limits of accuracy which have been set (see Section 3.4). The accuracy of the answer is denoted by the bar which appears on the right of the screen, as shown in Fig. 3.8. The bar runs up or down from the centre, depending upon whether the response is greater or less than the answer calculated by the computer (which is displayed to an appropriate number of significant figures at the bottom of the screen).

STANDARD FORM OPTION

For this option there are two types of question:

(a) converting floating point to standard form;
(b) converting standard form to floating point.

The second type requires you to input one value as for APPROXIMATION and ESTIMATION, but the first type (floating point to standard form) requires you to input two values, first the number and then the power of 10. The value you are required to enter is highlighted and you must confirm each part separately by pressing **RETURN**.

3.6 Viewing the score display

Your score can be viewed at any time from the question screen by pressing `ESC`. An example is shown in Fig. 3.9.

After you have checked the score, press

`R` to run the option you are currently using again from the beginning. This gives you the opportunity to change the topics and levels of difficulty.

`ESC` to return to the menu (see Section 3.1).
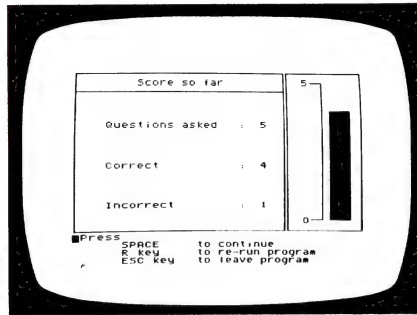
`space bar` to return to your question.

Fig. 3.9

ESTIMATION OPTION

In this option you cannot return to your question until you have first displayed the bonus. This is done by pressing the `space bar`. The bonus appears as a modification to the score column, although no bonus is available until at least five questions have been answered.

3.7 Leaving the program

The program is terminated as follows:

From a question

● press `ESC` at any time to get the score display.

From the score display

● press `ESC` to return to the menu.

From the menu

● type `4` followed by `RETURN` to choose the Finish Option. Instructions will appear on the screen telling you when to remove the disk and switch off your computer.

Summary of special keys

The following keys have special functions:

U   moves the level of difficulty bar **up**.

D   moves the level of difficulty bar **down**.

←   cancels the last typed character.

space bar   generates the next question.

ESC   (a) from a question, moves you to the score display; (b) from the score display, moves you to the menu.

RETURN   confirms your input.

R   runs the option again from the beginning, allowing you to reset topics and levels of difficulty.

CTRL **T**   erases the messages at the bottom of the screen. Pressing **CTRL** **T** again makes them reappear. Thus, if you find that the messages distract the pupils, they can be removed and restored when needed.

Approximation Option only

CTRL **P**   makes the next question the hardest within the chosen level.

B   highlights the other level of difficulty bar.

Estimation Option only

I   moves the bonus bars **in** (together).

O   moves the bonus bars **out** (apart).

This program is designed to develop the mathematical skills of approximating numbers, estimating products and quotients, and converting floating point notation to standard form and vice versa. The computer generates questions to the level of difficulty set by the user, and keeps count of the pupil's score.

Two attempts at each question are allowed before the correct answer is supplied; if the first attempt at an approximation is incorrect a hint will be given to help the pupil find the right answer. When estimating a product or a quotient the user can also set accuracy limits outside which the answer will be rejected. Bonus points which depend on the level of difficulty are available for these questions.

The teacher can use the program to provide graded practice in a selected topic to suit the requirements of a particular pupil or group. The visual display should stimulate the less motivated pupil, and encourage confidence in manipulating numbers among middle-school pupils.

Five Ways Software is a series of resource materials for teaching and learning with the aid of microcomputers. The programs have been designed by teachers and written so that those with little or no knowledge of computers can use the disks with confidence and ease.